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Graphical Method
Of Obtaining Value of "N"
In Kutter's Formula
In CCC Drainage Camps.

Division of Drainage Investigations

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(Experimental - not for general distribution)

Method of Obtaining Area and Hydraulic Radius

On cross-section paper of 20 divisions to the inch, the cross-section of each station of the slope course should be plotted with a sufficient scale to permit the scaling off of accurate measurements. Where possible, the same vertical and horizontal scales should be used so that direct measurements can be taken. However, in the case of wide channels, it may be desirable to have a different horizontal and vertical scale. If this is the case it must be remembered that distance cannot be directly scaled, but must be figured.

Points plotted from the channel soundings should be connected with straight lines so that the wetted perimeter can be accurately measured.

By means of a planimeter, the area of each successive foot or less in height should be obtained and an area curve plotted.

For each area obtained, the corresponding wetted perimeter should be scaled off and recorded and then plotted. If the vertical and horizontal scales are not the same, it must be remembered that the wetted perimeter must be figured and is equal to the square root of the sum of the squares of the horizontal and vertical distances.

The value of "r", the hydraulic radius, can then be determined for the various points taken for the area curve from the values of the area and wetted perimeter of those points. An "r" curve should then be plotted using these values of "r". It is important that an accurate "r" curve should be figured and plotted showing any unusual variations which may occur from wide differences between area and wetted perimeter at any one point.

The scales of the area curve should be such that the same accuracy can be obtained as that obtained on the planimeter. The "r" curve should have a scale such that values to one-hundredth of a foot can be obtained accurately. The wetted perimeter may be the same as that of the width.

In determining values for use in formulas or to be used on the Kutter's formula charts for a given water elevation, values of the area and "r" should be obtained from the curves for each station. A summation of these values should be made and average values determined. This average value will be the value of the area and "r" to be used in all computations or diagrams. It must be remembered that the water elevation at a given water stage will vary directly with the slope and so each station would have different water elevations which must be figured.

Method of Obtaining "n"

In the course of checking results of our first research investigation reports, it was found that errors are frequently made in computing "n" values. Since the necessary computations are somewhat complicated and there are possibilities of making slight variations in figures which will greatly affect results, it was felt that some system should be adopted for determining the value of "n" which would reduce the probability of incorrect results to a minimum and eliminate much of the time required to compute, check and recheck all of the calculations involved in solving the Kutter formula correctly.

The method proposed utilizes cross-sections of the slope course with accompanying area and hydraulic radius curves; two logarithmic diagrams of Kutter's formula with respective range values of "n" from .010 to .080 and .080 to .200; mean velocity of stream flow; and slope of the water surface.

The use of the Kutter Diagram on Logarithmic Base is very simple for having obtained the mean velocity by current meter readings and discharge computations, the slope from field observations and the mean hydraulic radius by averaging the values taken from the cross-section curves, the corresponding value of "n" is quickly determined as follows:

1. Determine on the chart the exact point of intersection of the lines representing mean velocity and slope.

2. With a pair of dividers determine the distance of this point to the nearest guide line.

3. Shift this measurement vertically along the guide line to its intersection with the line representing the mean hydraulic radius.

4. From this intersection with the hydraulic radius shift horizontally to the right and read the indicated value of "n".

It will be noted that there are diverging guide lines for certain values of "n" at the lower portion of the diagram. It is therefore necessary that measurements from the intersection point of the mean velocity and slope be made to the guide line with a value of "n" equal to that existing in the ditch. This cannot be done correctly without first making an approximate interpretation of "n" and then interpolating

the exact position of the guide line following this "n" value. This trial procedure is not as objectionable a feature as it may appear to be when first using the diagram.

The very limited use at this time of the above-described graphical method of determining the value of "n" in Kutter's formula indicates its practicability for use on the drainage research investigations and its accuracy is believed to surpass that of the present field practices.

Blueline prints from van dyke copies of tracings of the logarithmic diagrams of Kutter's formula and typical cross-sections showing arrangement of area, wetted perimeter and hydraulic radius cruves are made a part of this report.